Method for introducing additives:

The invention relates to a method for introducing additives into flowing or fluidised media. The spatially predetermined position of the additives in the flowing material, also called fluid bed, is obtained by controlling the pulsating injection, The introduction and exact dosing of additives, that is hardeners, dyes, gas producers and softener for instance, into a liquid plastic stream or metal stream for instance or the fluid bed of bulk material, such as powder, granules and pellets, is carried out by means of an injector. The invention is used in melting units, in hot channel systems, in tools , components of tools and injection moulding machines, extruder-, injection moulding-, pelletizing-, burner- and injection arrangements. The nozzle needle of at least one nozzle respectively is variable and highly precisely moved for the introduction by means of a device and in such a way that additive is dosed exactly in relation to the volume flow of the medium and that a pulsating stream is injected into the medium flowing past, by means of at least one well-aimed nozzle opening . The additives are dosed by means of a pressure that can be adjusted variable, pulse width and pulse frequency. The desired homogenous distribution is obtained by the penetrating injection jet during compounding for instance.

US 4474717 by HENDRY JAMES W dated 1982 an injection of spatially predetermine position is claimed:
Injection of a small portion of plastics without introducing inert gas (preloading) followed by sectional introduction of inert gas using frequencies from 4 to 100 cycle per second having a pressure of 300 – 1500 psi (2 to 10 MPa) into the continuous passing plastic material. The result is a multi layered inside foamed structure.
The submitted invention expands this method by applying injection technology used in the combustion engine technology. Reaching a more intensive penetration by higher pressure (40 to 200 MPa), higher frequency (100 to 1000 hz) and more exact dosing by controlled width of the pulses, frequency of the pulses and regulation of pressure using this technology.
Suggested design of nozzle and channels according to hydro-mechanical principles application for metal, bilk material and high viscous melts can be achieved.

The invention relates to a method for introducing additives into flowing medium by exact dosing and homogenous distribution. The following application, processes and devices coming to an economical realization:

- Introduction, dosing and homogenous distribution of additives as there are hardener, dyes, gas processors, softener, reactant into the melt stream of plastics in:
  - Extrusion systems for sheets tubes and profiles.
  - Compounding systems for production and adaptation of plastics.
  - Injection moulding-, blow molding-, and film casting-systems.
  - Auxiliary processing-, forming operation-, preform manufacturing-systems.
- Introduction, dosing and homogenous distribution of catalyzes, reactants in flowing liquid in chemical, processing systems as well as for instance distillation- water-treatment- refinery-systems.
- Introducing, dosing and homogenous distribution of bleaching agents, solvents into the circuit of pulp- and ground wood- systems.
- Introducing, dosing and homogenous distribution into alloys and metallurgical additives as well as gas processors into the metal melt flow of die casting, profile casting and continuos casting systems.
- Introducing, dosing and homogenous distribution of additives and flavor agents for pelletizing-, dough- and noodle processing – systems in the nutrition industry.
- Introducing, dosing and homogenous distribution of fuel into combustion systems.
- Introducing, dosing and homogenous distribution of dyes and solvents in airless- and spraying systems.
- Introducing, dosing and homogenous distribution of additives into fluidised material like bulk and powder material, granules, pellets in plants operating fluidized bed and whirl sintering installations.

Description of the invention:

The basic new idea of the submitted method for introducing additives consist of obtaining intensive atomizing, mixing and deep penetrating of additives into the medium stream by using high kinetic energy of the additives and exact timed pulsing and exact pulse width using appropriate injectors.
The exact dosing of the additives is obtained by regulation of the operation parameters of introduction for instance pressure, frequency, pulsing width a.s.o.
The state of the art of combustion engines using the „common rail" injection technology. The flexibility of this system by modifying the operation parameters is the highlight of this technology in comparison to the former used mechanical operated injection methods as there is injection nozzle ans.
The common rail is loaded with fuel being pressurized up to 200 MPa and supplies the injector with this constant pressure. Electronic controller activating solenoid and piezo-operated electro-hydraulic servo-valves to move the nozzle needle by push rods with high precision. According to this technology exact dosing and homogenous distribution will be obtained.
The application and further development of this injection technology is subject to utilize this improved technology for further applications as mention before.
Furthermore detailed design and configuring of nozzles, nozzle-needles, the arrangement of orifices in position and shape as well as arrangement of injectors are subject of this invention

State of the art concerning methods for introducing additives

The following devices and methods are subject of previous solutions:

EP161614 WOLTON FRANK 1985 showing a device for injection of certain amount of medium into the fluid stream. The adding of the additives happens by a charging pump which is activated by the flowing medium. Ân energetic mixing is not possible because of the small pressure difference.

The device of adding additives into a liquid stream of high viscosity has been introduced in US 5913324 SIGNER ARNO 1997.

By diaphragm the high shear forces of the medium with high viscosity the mixing takes place. A dosing is happening in the side stream and independent of the main stream.
A device of adding additives after the plastisicing unit is shown in
in EP0432336 CLOUP PHILLIP 1991.

For the adding of additives after the plastisicing unit the following methods are known.
WO89053226 HETTINGA SIEBOLT 1988
Blowing in of air

US4931236 HETTINGA SIEBOLT 1989
Spraying in of air/gas after the plasticising to achieve hose with foam layer.

DE1948454 BAYER 1971
Injection of chemical gas producer after plastisicing unit.

A mixing by energetic injection jet stream and pulsing dosing is not subject of the last named inventions.

A nozzle for application of glue by pulsation is shown in US 5934521 KOIKE KATSUHIKO 1998.
The nozzle-needle is activated by a pneumatic cylinder up and down, so that glue pours out in pulsing way. A mixing with a flowing medium passing by is not on purpose.
The pulsing adding of liquid and gas is state of the art in burner-, airless jet- and spraying- systems (atomizers).
The submitted invention is demarcating from these application by higher pressure of the liquid than 40 MPa and high energetic atomizing.
This pressure is not possible with the nozzles used by now. Only by electrical activated hydraulic servo valves in common rail technology these pulsation can be realized.

Description and economical benefit of the present invention.

Introduction into the plastic melt stream:
The introduction happens after the plastisicing unit.
This is for many processes listed below of advantage.

Recruiting material of different properties out of one plastisicing unit.
For Injection moulding systems predetermined properties like porosity, coloring are possible by one process step by variable introduction. Only multi-component injection moulding machines can do today.

For extruder systems profiles will be extruded with different components at predetermined sections can be foamed by diverting the plastic melt stream and introducing gas creators in one side stream by an injector so that this melt stream will expand an can be joined together with the material of the main stream.

Plastics for sheet and tube extruders can be introduced with dyes, gas processors, softener after the extruder and therefore a fast change of the material properties is possible what leads to economical flexibility in the production.

Pelletizing systems in the nutrition can be modified by introducing flavors and additives after the extruder by injectors, so that the material does not have to go through all the screw total length.

Chemical and process-technological systems like distillation-water-treatment plants and oil refineries.
The introduction and dosing and the homogenous distribution of bleaching agents, solvents in circuits of cellulose-, pulp and mechanical wood pulp happens according to the state of art by dosing units with subsequent mixing.
High shear forces are needed for the efficient mixing.
Any modification of the operation parameters as there is:
Change of amount of additives or
changing of color chemical additives
will have only an effect after completing a total running through of one plastisicing circuit.

Method of introducing additives

exact dosing and homogenous distribution

Description

The present invention relates to introducing additives for instance gas processors into the melt stream of plastics or low melting metals.

The advantage of this process is the application of light weight structures at locations of a part where it is demanded. The gas processing substance for expanding the matrix material is introduced in spatially predetermined positions. Various operation modes and combination of these can be obtained firstly by pressure differences between melt and gas processing substances and secondly by the frequency of pulsation and thirdly by the shape of the nozzle reaching into the melt channel:

Creation of foam:
Using high frequent pulsation and therefore atomizing at high pressure difference and advantageous at counterflow and subsequent high acceleration of the melt by variable sections of the melt channel. The difference of the speed of melt and additive is selected of high value.

Macro-hollow cavities:
The introduction happens by drop shaped dosing of the melt flow at low frequency of the pulsation and only small pressure difference in flow direction and essentially laminar streaming conditions of gas processors and melt.

Continuos introduction:
Continuos introduction of a string of gas processors at nearly adequate flow speed of the passing medium. Small pressure difference is of advantage.

An apparatus for injection molding of compound parts with charger, which are connected to a pump which is compressing chemical blowing agent has been published in DE1948454 by BAYER 1971 to achieve a spatially predetermined foaming. Because of the insufficient mixing and dosing the proposed foam quality cannot be reached.
The present invention is demarcating from the above apparatus by using injectors (combination of valve and nozzle) and pulsing injection and optional using a continuously pressurized pipeline „common rail" and hydro-electrical activated valves.

Because of the shaping of nozzles and channels according to hydrodynamic principles as well as regulated pressure the apparatus is different.
The solenoid is activated by electrical supply and optionally controlled by generating a arbitrary wave generator
This leads to operation mode like atomizing, dotation and continuos string
The selection of pressure difference and frequency of pulsation leads to a predetermined introduction of gas processors into the melt.
The exact dosing and pressure regulation leads to a targeted dotation of drops into the melt resulting in a subsequent macro hollow cavity expansion.

The apparatus for introduction of gas creating substances into the highly pressurized melt consists of a nozzle in immediate connection with servo-valve, or consists of a pump-nozzle system with a non-return-valve combination.

Especially the injection technology of combustion engineering reached a high state of art concerning the exact repeatability due to the demand of strict exhaust specification.
The state of the art:

A „fuel-injection valves for internal combustion engines" shown in DE2028442, 1970 by DAIMLER BENZ.
The hydraulic activation of the valve push rod is regulated by a three way valve.

An „Injection device" with hydro-electric activation was invented by PEUQUEOT in FR2145081 in 1971.
The valve is pushed by a continuos hydraulic pressure and released by a controlled pressure loss on the backside of the push rod.

In US3990422 at 1973 by BENDIX CORP the control of the hydro-electric activation has been improved by using a two circuit hydraulic system.

The present injectors showing features, being necessary to comply with the demanded application specification. These are: pressure regulation, elecro-hydraulic activation by a push rod valve and pressure controlled by a sphere valve at the high pressure circuit, which is necessary to reach the high frequent pulsation and having the high pressure available at the nozzle needle immediately at the valve seat by a common rail system, which makes the accuracy independent of pressure and velocity differences between the gas creating substances and the melt.

The present invention relates to this high pressure technology to be adapted for the special condition of the introduction into the melt.
The high pressure for injectors in combustion engines is needed for atomizing and distribution of the fuel in the combustion zone. The high pressure for injectors in melt introduction processes is needed to overcome the high melt pressure of about 100 to 140 MPa. Pressure of about 200 MPa can be reached by the available injectors with common rail. The continuos supply and the activation of the valves are solved with high reliability today.
An essential presupposition for running the injectors is the lubrication by the fuel. Since gas creating substances (water, alcohol, liquid gas) do not have substantial lubrication effect.
The basic idea of the present invention is the usage of two circuits applied to the standard injectors available in the market making additional measures.

The Patent JP 8170569 by NIPPON SOKEN 1994 is showing a version of injectors for diesel engines by using a high pressurized circuit for injection and a low pressurized circuit for the servo hydraulic system.

The present injector reaches by separation of the hydro-electrical activation of the push rod of the valve by using standard hydraulic oil and
The introduction of gas creating substances happens with a slightly lower pressure (different to the JP 8170569) because of non return lock pressure to prevent penetration of melt into the injector.
Only the needle and seat of the valve get in touch with the non lubrication medium. Since these parts can be made of sintered highly wear resistant and easy changeable. The electro-hydraulic servo circuit is not effected because of the separate circuit.
Further alternative solution for the injector are:
Pump nozzle system with a combination of high pressure piston and spherical valves.
An electric activated swing system attached to a pump piston.
Limits for the stroke and positioning of the inlet valve as known for airless spraying systems can be used as well.

In some application it is of advantage to have small pressure difference between the introduced material and the melt. For this the above solution can be used.
The regulation and control of the introduction process having the following features:

Optional the hydraulic circuit can be separated from the gas creating substances to be introduced. The pressure p_1 of the medium to be introduced and the pressure p_2 of the hydraulic system are regulated by a pressure limit valve.
The controller regulating the pressure depending on the melt p_3, for the hydraulic system circuit as well as the injection pressure of the introduced medium.
The injector is activated by solenoid or piezo actuator. The regulation is controlled by a „Arbitrary Wave Form Generator".
Furthermore the specification of hydraulic, nozzles, injectors and melt channel are described below.

The hydraulic for continuos production for instance extrusion, continuos casting
And for part production by injection moulding and die casting are prescribed.
The system for continuos production is used for extruders. Continuos charging and multiple injector assembly is preferred.
The system for part production is used in injection moulding and die casting systems. Because of the interruption after the injection a simple solution using a pressure multiplier double cylinder is offered for injection moulding systems.
Thy hydraulic system of the existing machine having usual a pressure of 26 MPa, which can be used to bring high pressure by a pressure multiplying system. While plastifacation takes place the pressure multiplier for the hydraulic system as well as for the introducing system is loaded with hydraulic oil and gas creating substance respectively.
For the dotation of the melt with concrete size and spatially predetermined position it is necessary to achieve a constant pressure difference while injection takes place. To high pressure difference leads to the destroying of the melt. The ramping of the pressure is shown in figure 9. The injection pressure increases till the nominal pressure while injection operation.
During the injection the gas creating medium must be introduced by a higher pressure than the melt. The velocity of the melt in the gate of the mould has to be equivalent to the introduction speed of the gas creating medium.
For reaching this feature an exact pressure regulation with electrical pressure limit and a precise activation of the hydro-electric valves is necessary. The shaping of the valve, valve seat and the smooth configuration of the melt channel according to hydrodynamic principles is important for repeatable dotation of the melt. The injectors of the „common rail technology" have the capability to fulfill these features.

The regulation of the solenoid takes place by controlling with „Arbitrary Wave Form Generator", opening and locking can be optimized by this system.
Furthermore the shape of nozzle and melt channel is described.

Method of introducing additives

exact dosing and homogenous distribution.

The present process relates to the modification of the properties (compounding) of an origin extruded material by divertion of the main stream into a side stream and introducing additives into this side stream by dosing, mixing and distribution of the original material.

The kind of additives determine the properties of the plastic material of the melt.

These additives are for instance additional components as there are hardener, dyes, gas processors, softener, filler and reinforcements.
This process can be applied to inside melt channels of mould for extrusion as well as for injection moulding systems, by means of using at least two diverted streams of melt to reach different properties of the plastic material.
Profiles produced by this process having different properties of the material on spatially predetermined positions.
This method saves an additional extruder to produce the additional material component.
The essential advantage is, that based on the same origin material the waste disposal is not necessary, because based on the same material the recycling results in a unique material.
The additives are introduced by nozzle, injector, charging tube, mixing head, porous sinter metal, sliding pump, charger and spraying system.
The following concrete application for production of profiles are subsequently shown for instance:

PVC Window profiles.

Sections of the profile close to the outside or inside can be insulated with the present process by using foam filling at the concerned chambers.

The calipers as used for the known multiple chamber systems will be adapted with inside channels and with the present described devices. From the main melt stream, diverted material comes to the channel duct within the caliber in which by means of a metering regulation (as there are valve, throttle) the melt is fed to the device for introduction of the additives. Subsequently devices for mixing and homogenizing are placed in the channel to complete the compounding process. Using PVC for the window profile the additive will be physical gas creators like water, carbondioxyd, alcohol, glycerin ans.

The pressure ramping in the melt duct is decreasing, for the additives giving additional gas volume. For expansion of the material a conical zone is configured according to the volume increase or according to the velocity increase the additional volume comes to a expansion zone (conical increasing outlet) so that the compounded material is lead to the outside solid PVC profile shells and can be homogenous and adhesive bound together.

The advantage of the profiles with multi components comes by the cost effective production and the better properties of the material for heat and sound insulation (low pressure within the foam cells and therefore lower heat transfer rates) and less cost for recycling of the waste material.

As variation the additives can be introduced by singular dotation and leading to a profile with honeycomb shaped cellular structures of high strength. These structures replacing the necessary stiffener profiles.

Window profiles out of Polyolefinen: as described above but using Polypropylen PP or Polyethylen PE, HDPE and so on.

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Claddings or panel shaped coverings for outside or inside walls.

More simpler than described above the total extruded profile with foam core and large cell structure can be obtained by one diverted material stream from the main stream to be compounded within the center of the profile. The subsequent process of calibrating and cooling remains the same as before.
The so obtained profiles can be used for inside cladding, mobile walls and having high stiffness by using large cell striker.

Tubes from PVC, PO

Because of suitable introduction of gas creating and/or fillers, or reinforcement to the melt stream into the spatially predetermined locations, as there are intermediate layer, outside layers ans. the multi component tube can be produced with simple measures. The device for compounding is attached in between the flanges of extruder and mould and is supplied by the channels of the mould to modify the properties of the material

Another production process with excellent mixing of the melt consists of introducing the additives before the cellular pump.
Another improvement can be installed by attaching a mixer or dynamic mixing head for homogenous compounding.

Coloring of the outside layers of the profiles.

The introduction of dyes into the diverted melt channel makes it possible to come to a fats changeable coloring process. Most economical, because the expensive dyes are only applied on the outside and no losses of material happen by changing of the color, since the extruder has not to be emptied completely therefore. The change of the color come into force immediately.

Further possibilities for cost reduction can be achieved by bringing the coloring to the outside layers only.

Production of sheets, insulation sheet material and compound sheets.

For system having a large working width the additives can be introduced into the center layer of the extruded sheet, or diverted to a melt channel similar as described before for the device as implemented into the calipers having the total width of the sheet.

Apparatus for adding up a extrusion system for multi component process.

The apparatus will be attached in between the flanges of the extruder and the mould.
Following elements are included:
Inlet cones with diverting device for the melt channels.
Pressure and volume metering system
Device for introduction of the additives optional consisting of nozzle, injector, charging pipe, mixing head, porous sinter metal, sliding pump, charger or spraying system.
The mixer consist of static mixer, for instance with shafts, pins, diaphragms, helical zones.
The expansion zone consists of variable sections, especially for foam components or macro cellular structures in the melt stream.

Apparatus for dotation and mixing of additives into liquid medium by using valve cone orifice or pocket hole orifice, especially hot runner valve.

The invention relates to a multifunctional mixing and dosing head, consisting of a nozzle cone and a nozzle needle, in which the volume flow is metered or blocking the outside flowing medium by the position of the outside nozzle needle and consisting of a nozzle cone and a nozzle needle, in which the volume flow is metered or blocking the inside flowing medium by the position of the inside nozzle needle

This combination of valve, nozzle and injector leads to a economical mixing and dosing directly on the needle top of the concentric double cone.
The invention also relates to a hot runner valve, having an injector, for introducing the additives into the outer flowing medium, instead of the valve needle
Several combination of mixing and dosing head are mentioned, especially the attachment in plastisicing unit, extruders, melt channel and the subsequent attachment of statical mixer systems.

The economical benefit consists of the spatially predetermined location of the dotation and the excellent mixing and the exact dosing according to the mixing ratio.
Application for this hot runner valve with integrated mixing head for introducing additives like dyes, hardener, softener, gas processors ans. directly into the plastic melt and immediately before the gate of the mould.
Besides the several known 2 component hot runner valves the present suggested solution is having following features:
The application of the concentric positioned nozzle needles within the nozzle needle.

In EP 0310 914 from 1987 „process for injection moulding" (BATTENFELD) a concentric positioned nozzle needle are shown in figure G.1 to 6.5.
The present apparatus is demarcating from the above by using a spatially predetermined dosing of the melt while in EP 0310914 only each of the two media is switched to the mould, while the present apparatus can achieve any mixing ratio in between by using the introduction of the additives by pulsation.

In US 4657496 from 1987 by HUSKY
A hot runner valve for 2 components is presented with concentric positioned charging tube. By the cavities (9) and (6) within the nozzle needle, depending on the position either the one or the other component is blocked or open respectively. The concentric shaping of the inside located nozzle makes it possible to regulate the dosing by moving the outside nozzle needle. Which is controlled by the inner or outer nozzle.
A mixing or a fast pulsing introduction as shown by the present apparatus is not subject of the US4657496 Patents.

The target of the present invention is not only to introduce at least two media in a concentric manner, but also achieve a mixing i.e. to dotate the outer medium with the inner medium.

In US 5286184 a variation of the concentric nozzle is published, which differs to US4657496 the activation of the hollow shaped nozzle needle. Also in this case there is a concentric introduction, but no mixing or dotation is the target.

The nozzle needle is activated by a push rod within the boring of the nozzle needle and is regulated by a servo-mechanic.
To reach a spatially predetermined position by the dotation and/or dosing and excellent mixing the usage of a valve cone orifice VCO and a CDI injectors, as it is used in the combustion engines of advantage.
The activation of the injector is known by a hydraulic piston but also can use for the servo-mechanics for instance solenoid, piezo actuator hydraulic servo.

Description of the figures:

Indexing of reference numbers:

1. Nozzle needle precisely moved
2. Nozzle body
3. Nozzle needle seat
4. Plane plurality of orifice arrangement
5. Cavity at valve cone orifice VCO
6. Radial plurality of orifice arrangement
7. Axial boring in nozzle body
8. Cavity at valve sack orifice
9. High pressure pump
10. Channel of streaming medium
11. Injector
12. High pressure piping
13. Leakage backflow piping
14. Container of additives
15. Common rail (communication system)
16. Cellular pump
17. Streaming medium
18. Injection spray stream
19. Plastisicing barrel
20. Dosing chamber of barrel of injection moulding machines
21. Nozzle of plastisicing barrel
22. Mould
23. Hot runner system
24. Non-return-valve
25. Airless spraying system
26. Compressor
27. Combustion air piping
28. Combustion chamber
29. Combustion zone
30. Inner rod (caliber) of extrusion mould
31. Section of extruded profile
32. Inner rod (caliber) for hollow section
33. Foamed inner section
34. Hollow section
35. Extruded profile
36. Cascade shaped injection
37. Radial plurality of orifice arrangement for extrusion
38. Core of the mould
39. Jet streaming combustion air
40. Screw of plastisicing unit
41. Expansion zone in the extrusion mould, preferable situated in the inner rod of the mould

51 Mould for production of profiles by extrusion

52 Melt stream, feeding of melt from extruder to the mould

53 Caliber inside the melt stream section, implementation for the mould to conduct the melt stream, particular with an integrated melt channel.

54 Injector, nozzle for introducing of additives into the separately arranged melt channel.

55 Introduction of additives
55a Introduction in flow direction
55b Introduction in counter flow

56 Outlet section of separately arranged melt channel.

57 Caliber inner rod for forming a hollow section and hollow profile.

58 Melt channel with original shaped extruded profile and the corresponding section.

59 High pressure pump for additives.

60 Zone of expansion for the introduced gas creating additives.

61 Adjustable section for controlled outflow, chicane for mixing

62 Adjustable section for controlled inflow.

63 Pressure sensoring cell for the separately arranged melt stream as indicator.

64 Caliber inner rod with melt channel and inlet opening.

65 Tubular inlet section for multiple shell arrangement for extrusion profiles.

66 Central inlet opening for the inner shell of the extrusion profile.

67 Intersecting melt duct, passing through main melt stream

68 Flange of the mould

69 Flange of the extruder

70 Intermediate add up equipment

71 Extension of the melt stream channel

72 Intersection through the melt stream channel

81. Melt medium nozzle needle outside
82. Additive nozzle needle inside
83. Coaxial conical needle seat
84. Bolt in boring to activate the additive nozzle needle
85. Supply of additives to the boring
86. Details of mixing and dosing device
87. Valve cone orifice, Pocket hole orifice
88. Common rail injector (CDI injector)
89. Supply channel for melt stream
90. Activator piston by hydraulics
91. Supply of the additives
92. Introduction of additives to the melt
93. Servo-mechanics for instance electro/hydraulic, piezo/hydraulic
94. Hotrunner Nozzle seat
95. Injection Molding nozzle seat
96. Injection Molding plastisicing nozzle
97. Extrusion nozzle seat
98. Supply device
99. Melt channel for extruders
100. Statical mixer

101 Feeding device for gas creators
102 Pressure controller for gas C. p1
103 Circuit for gas creator substance
104 Hydraulic circuit for activation
105 Feeding device for hydraulic circuit
106 Pressure control for hydraulic c. p2
107 Tank for hydraulic oil
108 Spheres for valve
109 Solenoid or piezo activator device
110 Hydraulic activation of the valve
111 Back pressure, seal
112 Valve for the injector
113 Nozzle of injector
114 Gate of the melt stream
115 Pressure sensor-cell in melt stream
116 Adapting device between the runner
117 Introduction of additives to the melt
118 Heaterband of the adapting device
119 Pressure control for additives p3
120 Arbitrary Wave Form Generator
121 Pressure controller for additives
122 Controller
123 Interface to injection moulding machine, extruder, die-casting
124 Pump-nozzle combination
125 Leakage piping
126 Supply piping for hydraulic
127 Anchor for solenoid activation
128 Injector
129 Throttle valve
130 Valve push rod
131 Spring for clamping
132 Feeder piping for gas creator
133 Additional channel for 2nd medium
134 Stopping device f. stroke limitation
135 Pump push rod
136 Feeding pipeline valve
137 Feeding pipeline for sphere valve
138 Reverse motion spring
139 Backpressure valve on melt end
140 Leakage pipeline
141 Shrinkage of sphere seat
142 Hydraulic system of basic machine
143 Pressure multiplier piston additive
144 Pressure multiplier piston hydraulics
145 Axis for force in MPa
146 P1 pressure of additive
147 P2 pressure of hydraulic
148 P3 pressure of melt
149 P5 pressure on control piston
150 Axis of time
151 Current supply to solenoid
152 Center line
153 Trapezoid wave shape
154 Triangle wave shape
155 Half sinus wave
156 Full sinus wave
157 Periodic wave form
158 Unsymmetrical full sinus wave
159 Heaterband for injector
160 Injector
161 Introduction in flow direction
162 Adaptation to the mould
163 Spraying in melt flow / counter melt flow
164 Volume enlargement after continuous introducing of additives
165 Nozzle body
166 Slot shaped nozzle
167 Radial shaped nozzle borings
168 Valve cone orifice
169 Enlarged Laval channel
170 Nozzle needle open
171 Channel of nozzle
172 Valve cone orifice nozzle channel
173 Conical nozzle needle, axial spray

Description of the figures:

In figure 1 and 2 nozzles and nozzle needles and needle seats are shown. The subsequent figures 3 to 17 showing samples for the application of the present method of introduction with exact dosing and homogenous distribution.

Figure 1 showing a valve cone orifice VCO nozzle tip. With (1) the nozzle needle closing the needle seat (3) located in the nozzle body (2). The small volume of the front chamber (5) is the target of the VCO. The orifices (4) are inclined about 80° to the axis as used in combustion engines. Other orifices (6) shown on the right side of the axis having a stepwise inclinations of 0° to 75° inclined to the axis.
In figure 2 a pocket hole orifice is shown. The larger front chamber (8) of the nozzle gives a larger volume of free drops, by means an inexact dosing. The larger chamber gives the possibility of several radial arranged orifices (6) as well as an axial positioned orifice (7).

In figure 3 an arrangement of a dosing and mixing arrangement for a flowing medium in a tube (10) is drawn. 5 injectors (11) reaching into the tube. The injectors are connected to a high pressure pipeline (12) containing the additive. The tank (14), the high pressure pump (9) and the common rail (15) and the leakage pipe (13).

In figure 4 an arrangement of figure 3 is shown from the top view for a extrusion system. The dosing and mixing unit is positioned in flow direction between the cellular pump (16) the mixing tube (10) and mixer (10) and the mould (22)

Figure 5 showing a sectional view of the tube (10) enlarged. The 5 nozzle tips (2) are in a radial 72° pattern arranged. Each nozzle top is having 7 orifices positioned in an angle of 75°, 50°, 25° and 0° ans. The jet of the injection (18) giving a complete covering the section of the medium (17). The length of the jet stream is determined by the diameter of the orifice and is usual between 0,11mm and 0,14mm.

The figure 6 shows a mould for an extruder producing a cylindrical profile. Two of the several arranged injectors (11) are shown in the section. The additives (18) are introduced according to the velocity of the medium (17) in the flow direction.

In figure 7 the detail of the nozzle arrangement is drawn. The nozzle bodies (2) having at least one orifice (4) in the direction of the melt channel. The jet stream is directed to bring the additives not wall sides (10), but into the core (38) of the stream

In figure 8 an application for a single injector is arranged which is inclined about 45° to the tube axis (10). The orifice (4) is inclined in a flat slope angle to the medium flow i.e. the orifice is positioned about 40° out of the axis of the injector. The pulsing introduction is giving a cascade distribution shown in figure 9.

Figure 10 gives applications for injection moulding systems. Similar to figure 8 and 9, two injectors (11) are introducing the with a light slope in direction of the axis of the nozzle tip (21) of the plastisicing unit. The location of the injector is after the screw tip (40) but within the front chamber (20) of the barrel (19).
For further excellent mixing for instance of dyes of advantage. This arrangement also can be placed within screw sectors within the plastisicing arrangement.

For accurate dosing with less mixing the arrangement of figure 11 rakes place. The introduction happens in the center hole of the plastisicing nozzle tip (21). This is used for application with hardener and softener (minimum leakage).

In figure 12 the introduction happens by the injector (11) immediately after the mould gate at the inlet of the mould (22). The advantage of a hot runner system (23) is evident.
The Mixture of medium and additives is not depending on the plastisicing unit (19) but determined by the introduction of additives i.e. flexible and variable.

Figure 13 is showing an airless jet stream (25). The flowing medium (39) is the streaming side air. The additive is dyes (18). The pulsation determines the coloring conditions.

The nozzle arrangement is shown in figure 14. At least one orifice (4) in the nozzle body (2) is directed near the axis and determines the spraying structure (18).

In figure 15 the dosing and mixing arrangement is shown for a combustion system. The nozzle body (2) is reaching into the combustion chamber (27) and is limited by the casing (28) of the burner zone. The combustion air is compressed by a blower (26) and the atomizing of the fuel using the standard arrangement of orifices located on a cone.
The injection jet stream (18) results a accurate dosing and mixing of the perfect combustion. (29)

In figure 16 a and b the application of a mould for an extruder production of profiles - for instance of window profiles - is arranged. The dosing and mixing having the purpose do modify material diverted from the main stream of the melt for example with gas processors. The section shape is shown in figure 16 b. The injector (11) reaching into the side channel (30). The different material streams (31) are separated by inlet channels, calipers (32). The melt stream (17) is introduced (18) by additives and is creating foam in the side stream which is transported to the chambers (33) and (34). Chambers with solid calipers creating hollow profile space as usual.

In figure 17a and b the introduction of additives (18) by pulsation into the side channel is shown. The arrangement is also for extrusion systems as in figure 16 as well as for pelletizing and continuous casting with mixing zone (10) applicable.
Figure 17a showing the tube section (30) and the single tube (10)
Figure 17b showing the lateral section of the tube (30/10).
The nozzle body (2) is having 7 radial arranged orifices (4) and giving full coverage of the material section (17) by the jet streams (18) for dosing and mixing.

A sequence of several jet streams (36) respectively (37) introduced in flow direction are shown in 17b.

In figure 18 the total apparatus for injectors of standard design is given in the layout.

The using of pumps (101) and (105) enable the application to be used in a continuos operation (extrusion). The circuit for the additives (103) is separated from the circuit of the hydraulic oil of the servo (104). The pressure of the circuits is regulated by a electrical activated presser limit valve (102, 106). The valve (112) is released by a electro-hydraulic mechanics. This mechanics consists of a solenoid (109) a spherical valve (108) and the push rod connected to the high pressure piston (110). The controller (122) is regulating the electro-hydraulic mechanics according to the information (120) given by the operation data as there is injection time/extrusion data (123) according to the pressure sensor in the melt (115) of the pressure of the additive circuit (102) and the pressure of the hydraulic oil of the servo (106)

The arbitrary wave form generator (120) creates the opening current for the electro mechanism (112). The introduction of the gas processors (117) into the melt stream (114) happens in the interface (116) part after the extruder tip (160) by a nozzle (113) reaching into the channel. For heating a Heaterband (159) is located around the nozzle (113).

Figure 19 showing an standard injector. This version showing a pocket hole valve (113) with a small front chamber.

The valve seat (112) is locking the nozzle from the continuos pressurized circuit. The push spring (131) increases the force resulting of the difference of force on the nozzle needle (112) and the hydraulic pressing (110).

The opening is activated by the solenoid (109) which releases the sphere of the valve (108) and hydraulic oil of the servo is streaming out of the high pressure chamber (110).

Figure 20 showing an injector of the state of art. The essential features can be already recognized. The version with the electro-hydraulic activation is extended by throttle (129) and anchor(127) and double chamber.

Standard Injectors having separate inlets (126) for the servo supply and the injection supply.

Figure 21 gives a section of a modification of a standard „common rail injector". The already available two supply borings are attached to a special fitting.

Figure 22 showing the modification of a standard „common rail injector" with a second boring. The supply (132) of the hydraulic servo circuit is blocked by a pin.

Additional supply is given by a boring (133) and a second fitting (126) for the servo circuit.

Figure 23 showing a pump-nozzle configuration in principle, by means the high pressure chamber is close to the nozzle located. The medium of the additive is supplied through a boring in the push rod (135). And the pressurizing is effected by a inlet- (137) and an outlet-valve (139). The penetration of the melt into the injector is prevented by a sphere (137) which is pressed by a non-return-spring (138) into the valve seat.

The push rod (135) is activated by a magnetic swing system (127). By stroke limit (134) the size of the pulsation is determined. The line for leakage (140) returns the overflowing medium.

Figure 24 is showing the principle of an airless spraying state of the art system, applied for the present application by using a valve sphere (139) within the nozzle. The advantage of a small front chamber can be reached by a overlapping (141) of the sphere valve. (134,135,140) as shown in figure 23.

Figure 25 is showing a hydraulic system for part production for instance for injection moulding and die casting systems. The operation of the injector is having a twin circuit system. The pressure multiplier is connected to the basic hydraulic system of the machine (142). While processing the part there is time to load the system for injection. The pressure multiplier cylinder for the additive (143) and for the servo hydraulic oil (144) are pressurized being regulated by the pressure limit valve (142) during the melt injection having the pressure p_4. Subsequently the chambers of the cylinders are refilled by pumps (101) for the additive and pumps (105) for the hydraulic oil.

Figure 26 showing the features of the pressure ramping y-axis in MPa (145) over the duration for the present processing.

The melt pressure p_3 is shown by the curve (148), The pressure of the additive p_1 is shown by curve (146), the pressure of the servo hydraulic p_2 shown with the line (147).The electric potential (153) to activate the electro-hydraulic regulation is shown by the curve (149). Various wave forms are for triangle (154) for half sinus waves (155) for different frequencies and full sinus wave form (156) and the same with different frequencies and phases (157) full sinus form in

Created for different phases and (158) unsymmetrical wave forms by an arbitrary wave form generator.

Figure 27, 28 and 29 showing several melt channels.
Figure 27 a parallel melt channel (114) in flow direction positioned orifice having an interface part (116) between mould (162) and nozzle tip (160) of the barrel.
This arrangement is applicable for dotation with drops (161) into the melt stream (114).
Figure 28 a radial multiple orifice (163) in flow and counterflow position for excellent mixing of the additives with the melt in a enlarged melt channel (114) which causes additional mixing by change of velocity.
Figure 29 a continuos string introduction (164) into the melt channel. These method is able to process axial hollow cavities for extruded profiles.
Figure 30,31 and 32 a nozzle with various orifices.
Figure 30 state of the art
30a VCO valve cone orifice
30b radial multiple orifices
30c pocket hole orifices
Figure 31 a nozzle for flow and counterflow introduction
For introduction of additives as drops into the melt the nozzle is design according to hydrodynamic principles.

For preventing atomizing sharp edges have to be avoided.
The channel profile having smooth profiles in valve cone (17z0) and at the nozzle profiles (171).
Figure 32 a nozzle introducing drops sidewise in flow direction.
Figure 33 a nozzle for atomizing in the conical seat (172) and plane seat (173) rectangular to the flow direction.

Figure 34 shows a detail of the device for compounding a melt stream. This version is implemented in calipers (53) of profile moulds. (51) or for array assembly for moulds to produce sheets.
The section is showing detail of figure 16 a and b.
The view showing the material flow from right to left.
The caliber (53) at the inlet side is conical (64) shaped. The inlet is having a pressure sensor (63) connected to the controller (62) and supplying data it.

The introduction in flow direction (55b) and counterflow (55a). The advantage of the counterflow is the save introduction of individually closed dotations. The introduction optional by pulsation. For instance chicanes for the melt. The change of velocity leads to shear forces and to additional mixing respectively. The expansion zone (60)

Figure 35 showing the top view of figure 34 the relevant numbers are the same. Note the narrow section in the melt channel.

In figure 36a and b the section of the outlet is shown related to the device in figure 34 and 35
Figure 36b showing the inlet in a sectional view.

Figures 37a and 37b showing the version as it is in figure 33a and 33b but for simple foamed profiles as there are claddings with insulation integrated, panels and tubes.

Numbers the same as in figure 33.
Figure 38 a version of melt channel before the distribution chamber of the mould. Two inlet cones (64), (65) and the center inlets (66) giving a twin chamber of the melt.

Figure 39 a version of melt channel design with central inlet of the side channel and a concentrically (twin) introduction of additives and subsequent merging the melt at spatially predetermined locations of the profile.
The melt channel is crossing the main channel (67) in the center of the surrounded flow.

Figure 40 a showing a rectangular profile, 40b circle, tube profile, 40c elliptic profile, 40d rounded rectangular profile.
Several profile shapes with multiple components are shown for instance in figure 33, 38, 39 and 41 being produced as simple tubular profiles.

Figure 41 sketches a device with a add up for existing extrusion systems and can be modified for multi component operation. (68) is the flange of the 69) the flange of the extruder.

(70) is the interface part for adding up and (71) is the melt channel with through put.

Figure 42 showing the device in Fig. 41 in detail.

The device is made out of a disc (70) and attached between the flanges (68) and (69).

The disc having the injectors for introduction of the additives as well as diaphragms (72) to divert the melt channel. The tube (72) with attached planes for the hollow calipers is shown in principle.

In figure 43 to 46 hot runner valves for injection moulding systems are shown.

Figure 44 a present device in comparison of the state of art.

Figure 45A to 45C the activation of the needle top.

Figure 46A to 46C the above in detail.

Figure 47 the version with high frequency pulsing (CDI Injector)

Figure 48 the integration of CDI Injectors in the hot runner valve.

Figure 49 the arrangement of a mixing and dosing head for example in the melt channel of the plastisicing unit of a injection moulding machine or an extruder.

Figure 50 showing an arrangement of a twin unit in counterflow used for liquid/liquid mixing as well as for extruders with an subsequent static mixer.

Figure 43 showing a device for mixing and dosing and dotation. The inner nozzle needle (82) is activated by the adjusting device (93) and is giving the (83) of a pocket hole orifice or a valve cone orifice.

This insert also is part of the outer nozzle needle and shaped to be attached to the (90)

The supply of the additive happens by the boring (85) and is again attached to the interface (91).

The viscous medium is supplied by the channel (89) and coming to between the outer nozzle (81) and the supply tube (94,) for instance a hot runner valve a plastisicing unit or a melt channel of an extruder to the final destination.

Prior Art: showing the version of an inner nozzle needle as a push rod (84), as well as the inner nozzle seat, as well as the outer nozzle (94), or both according to the position of the push rod (84) for opening or locking. The outer nozzle needle is moved and regulated according to the supply of the outer medium.

In Figure 44 the present device is shown and having a nozzle insert (83) as shown in the figure as a valve cone (VCO). The orifices of the inner nozzle (83) are completely covered while (82) locked.
The inner substance is supplied between the nozzle needle (82) and the valve cone orifice (83) and is introduced in the inlet to the outer

According to the position of the inner nozzle (82) the pulsation, the atomizing of the introduced substance (85) into the outer medium (89).
The conical shaped outer nozzle needle (83), being at the same function for the inner nozzle needle is locking the orifices of the nozzle seat of the hot runner (94) Of the plastisicing unit (95) or of the melt channel of an (97), and regulates the opening according to the demanded volume flow and the introduction of the two media (92).
In figure 45A the open position for introducing the outer medium is shown.
The outer nozzle needle (81) is open, the inner nozzle (82) is closed.
The substance (85) cannot penetrate.
In figure 45B the inner nozzle needle (82) is open and giving space for the valve cone orifices (83) and the inner substance (85) is introducing to the outer medium (92).

In figure 45C the inner- (82), as well as the outer nozzle needle (83) is closed.

Figures 46A , 46B, 46C are corresponding to the figures 45A, 45B, 45C but in enlarged details.

Figure 47 showing the combination of a CDI injector (88)
In a nozzle seat as cone valve/pocket hole nozzle (87), having the function of the nozzle needle in the needle seat of the melt channel and closing the valve seat of the hot runner valve (94).
The CDI injector is activated by the position device (93).
The inner nozzle needle is activated by a solenoid/hydraulic or a piezo/hydraulic servo.
The supply of the substance happens through the fitting (91).
The melt is supplied by the channel (89).

Figure 48 is showing details of figure 46 and differs by the melt channel (89) attached as a separate insert (87).

Figure 49 showing the arrangement of a mixing and dosing head (95) inside the nozzle tip of the plastisicing unit (96) of an injection moulding system.
The insert (87) reaching into the mixing head (95) and the outer nozzle (81) the same time as the insert (87) regulates the flow of the melt (89).

Figure 50 showing the dosing and mixing head (98) in a tube for instance in a tube as liquid/liquid mixer of a melt channel of a extrusion system (99).

The inserts (87a, 87b) reaching into the conical nozzle seat of the mixer and modifying the outer nozzle needle (81) according to the position of the volume flow of the melt (89).

The supply happens by a charging device (97) and into the conical valve seat.
The additional mixing by arranging the mixing heads in a counter flow to have counter impact of the media flow.
Optional having this arrangement 4 media can be mixed together.
Optional a static mixer can be attached subsequent to the mixing and dosing device.